8.4. The Fourteenth Century

Note. Eves describes the fourteenth century (in Europe) as "relatively barren, mathematically" (page 264). The century saw the death of 25 million people due to the "black death" (or the "bubonic plague" which peaked in Europe from 1347 to 1351) and the Hundred Years' War (which lasted, of and on, from 1337 to 1453). The war was between England and France and started when the English made claims to the French throne after the death of France's King Charles IV. The Italian Renaissance also began in the fourteenth century.

Note 8.4.A. Eves only mentions two mathematicians in this section. The first is Nicole Oresme (1323–July 11, 1382), a Norman philosopher/mathematician (in the northern part of modern-day France) who later was a bishop in the Roman Catholic Diocese of Lisieux. He studied at the University of Paris in the 1340s, where he developed an interest in natural philosophy. In 1355 has was awarded the degree Master of Theology and was appointed as Grand master of the College of Navarre at the University of Paris. Starting in 1362 he worked within the church, was an adviser to King Charles of France, and then was appointed bishop of Lisieux in 1377. In his work, he translated into French Aristotle's (384 BCE–322 BCE) *On the Heavens* and other works. Oresme questioned some of Aristotle's conclusions (such as his definition of time as it relates to motion). He introduced a type of coordinate geometry in his *De configurationibus qualitatum et motuum* ("On the Configurations of Qualities and Motions"; a translation into English was given by Edward Grant in *Nicole Oresme and the Kinematics of Circular Motion: Tractatus de commensurabilitate vel incommensurabilitate motuum celi*, [Madison: University of Wisconsin Press, 1971]). This work was reprinted several times and it is possible that Descartes (March 31, 1596–February 11, 1650) was influenced by it when his introduced coordinate geometry. Another work by Oresme, *De proportionibus proportionum* ("Of the Proportions of the Proportions"), contains the first use of a fractional exponent (not in modern notation). This was also translated into English by Edward Grant as *De proportionibus proportionum and Ad pauca respicientes* (Madison: University of Wisconsin Press, 1966). In 1377 Oresme wrote *Livre du ciel et du monde* ("Book of Heaven and Earth") in which he opposed the theory of a stationary Earth as proposed by Aristotle and proposed the rotation of the Earth. At the end of the book he rejects his own ideas (it would take 150 to 170 more years before Copernicus [February 19, 1473–May 25, 1543] was to popularize this idea). Eves states (page 264) that Oresme wrote five mathematical works, and that in an unpublished manuscript he was able to sum the series $\sum_{n=1}^{\infty} \frac{n}{2^n}$, making him "one of the forerunners of infinitesimal analysis." This historical information and the following image of Oresme is from the MacTutor biography of Oresme (accessed 6/17/2023).

Note 8.4.B. "The meditations of scholastic philosophers let to subtle theorizing on motion, infinity, and the continuum, all of which are fundamental concepts in modern mathematics [in the area of analysis]" (Eves, page 264). We just saw that Oresme had an interest in motion and infinite series. The other mathematician mentioned by Eves in this section is the English mathematician and theologian Thomas Bradwardine (circa 1295–August 26, 1349). He was awarded a B.A. from Merton College, Oxford in 1321. He continued additional education in logic, math, and philosophy. In 1339 he became chaplain to English King Edward III (who claimed the French thrown as well, leading to the beginning of the 100 Years' War). Bradwardine was elected as the Archbishop of Canterbury on July 10, 1349, but he died of the plague seven weeks later. Bradwardline wrote *De proportionibus velocitatum in motibus* ("Of the Proportions of Velocities in Motions") in 1328 which dealt with Aristotle's version of physics. He gave mathematical arguments to show that some of Aristotle's assertions were inconsistent and he proposed resolutions. These problems concerned the force and resistance of an object in motion (to put it in modern terms). Bradwardline's resolution was not correct, however it was accepted as a law of mechanics for the next 100 years. In *On "it begins" and "It ceases"* Bradwardine argues that a temporal (time) interval has a first instant but no last instant because the end of the interval is marked by the first instant of its non-existence. This argument sounds somewhat like the idea of a Dedekind cut, which was used to formally define the real number line in the 1870s; for more of an explanation, see my online notes for Calculus 1 (MATH 1910) on Appendix A.6. Theory of the Real Numbers. In *Speculative Geometry* is a work on elementary geometry, some of which is not based on Euclid. The work *Speculative*

Arithmetic is based on a text by Boethius (circa 480 CE–524 CE), but historians are not in agreement that it is due to Bradwardine. Bradwardine in *On the Continuum* addresses the atomic theory of Democritus from a philosophical view, much like Aristotle. His argument against atomism includes: “No continuum is made up of atoms, since every continuum is composed of an infinite number of continua of he same species.” This historical information and the following image of Bradwardine is from the MacTutor biography of Bradwardine (accessed 6/17/2023).

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